Supporting information

Sn-TiO_2/PTA Nanocomposite Films for High-Contrast Rewritable Media with Visible-Light-Driven Black Coloration

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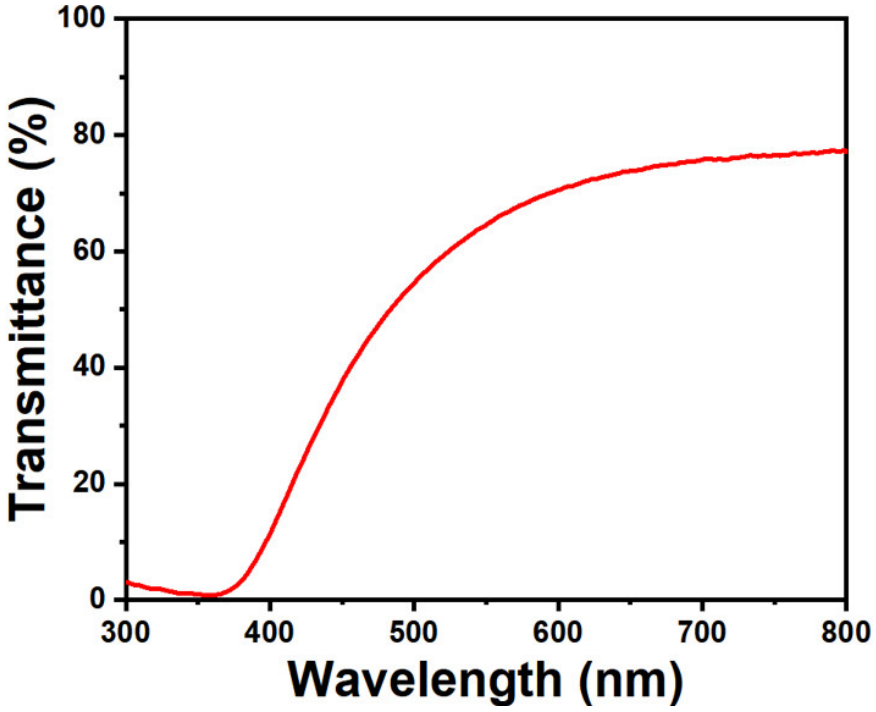

Figure S1. UV-vis transmittance spectrum of the typical Sn-TiO_2/PTA/PVP nanocomposite film.

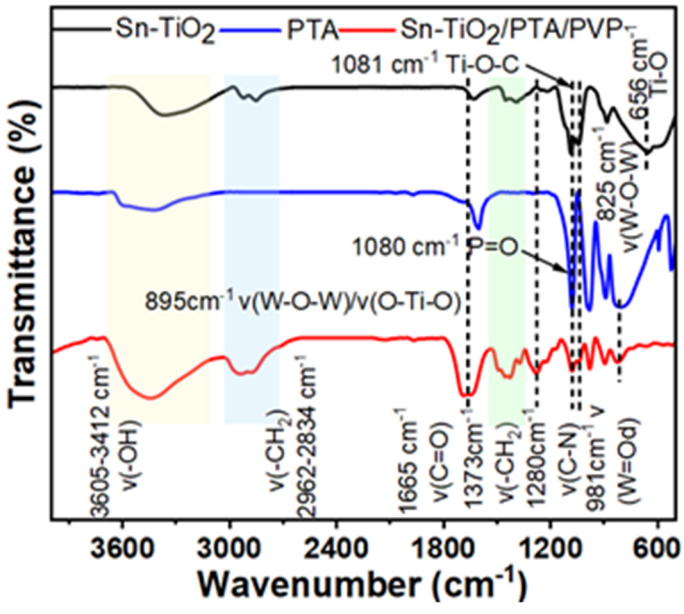

Figure S2. FT-IR spectra of Sn-TiO_2, PTA, and the typical Sn-TiO_2/PTA/PVP nanocomposite film.

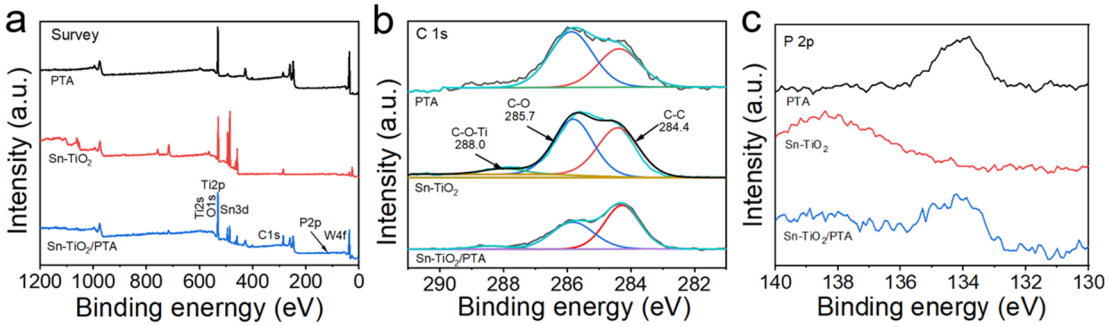

Figure S3. Survey XPS spectra (a) and high-resolution XPS spectra of C 1s (b) and P 2p (d) of PTA, Sn-TiO_2 nanoparticles and Sn-TiO_2/PTA nanocomposite.

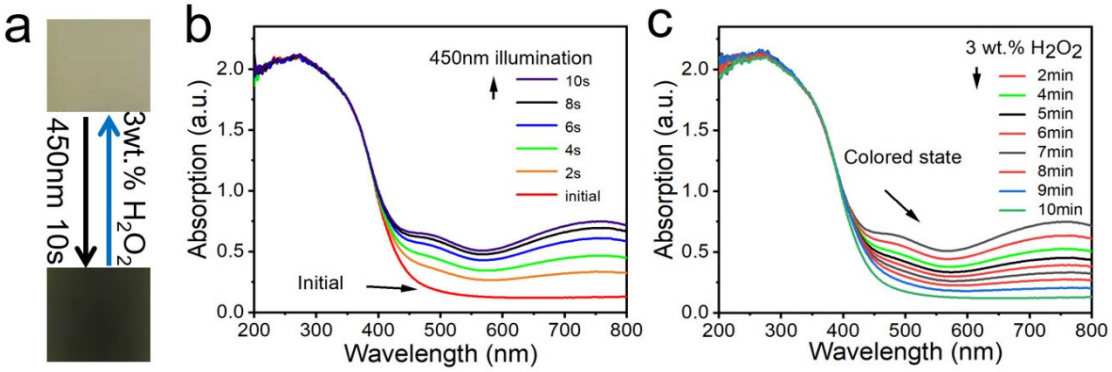

Figure S4. (a) Digital photographs showing the color switching process of the Sn-TiO_2/PTA/PVP nanocomposite film (the molar ratio of Sn-TiO_2:PTA is 3:1) upon 450 nm illumination and treatment with H_2O_2 vapor. (b, c) UV-vis diffuse absorption spectra showing the coloration process upon 450 nm illumination (b), upon the bleaching process in the 3 wt.% H_2O_2 condition (c).

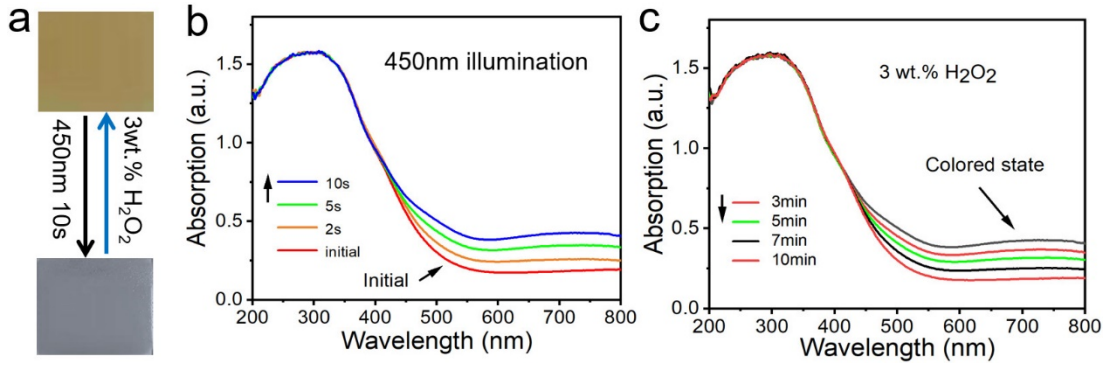

Figure S5. (a) Digital photographs showing the color switching process of the Sn-TiO_2/PTA/PVP nanocomposite (the molar ratio of Sn-TiO_2:PTA is 7:1) upon 450 nm illumination and treatment with H_2O_2 vapor. (b, c) UV-vis diffuse absorption spectra showing the coloration process upon 450nm illumination (b), upon the bleaching process in the 3 wt.% H_2O_2 condition (c).

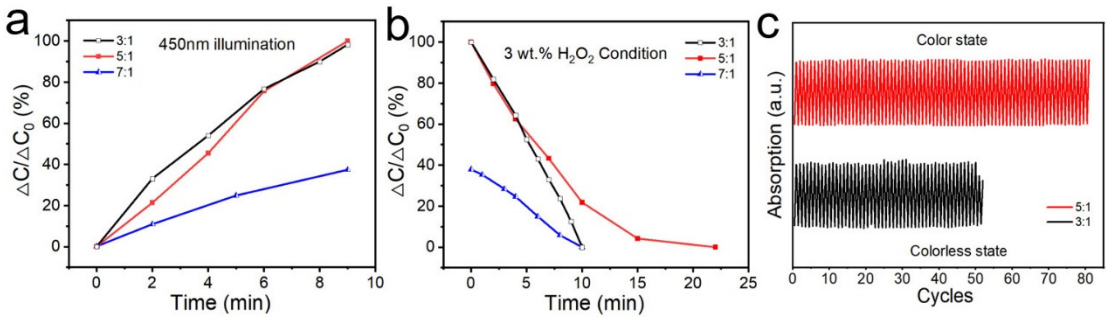

Figure S6. (a) The coloration rate and (b) the bleaching rate of Sn-TiO_2/PTA/PVP nanocomposite films with different Sn-TiO_2:PTA molar ratios under 450 nm light illumination in the initial state, treatment with vapor of H_2O_2, respectively. (c) Absorption intensity at 750 nm of films with Sn-TiO_2:PTA molar ratios of 5:1 (80 cycles) and 3:1 (50 cycles) during continuous color switching.

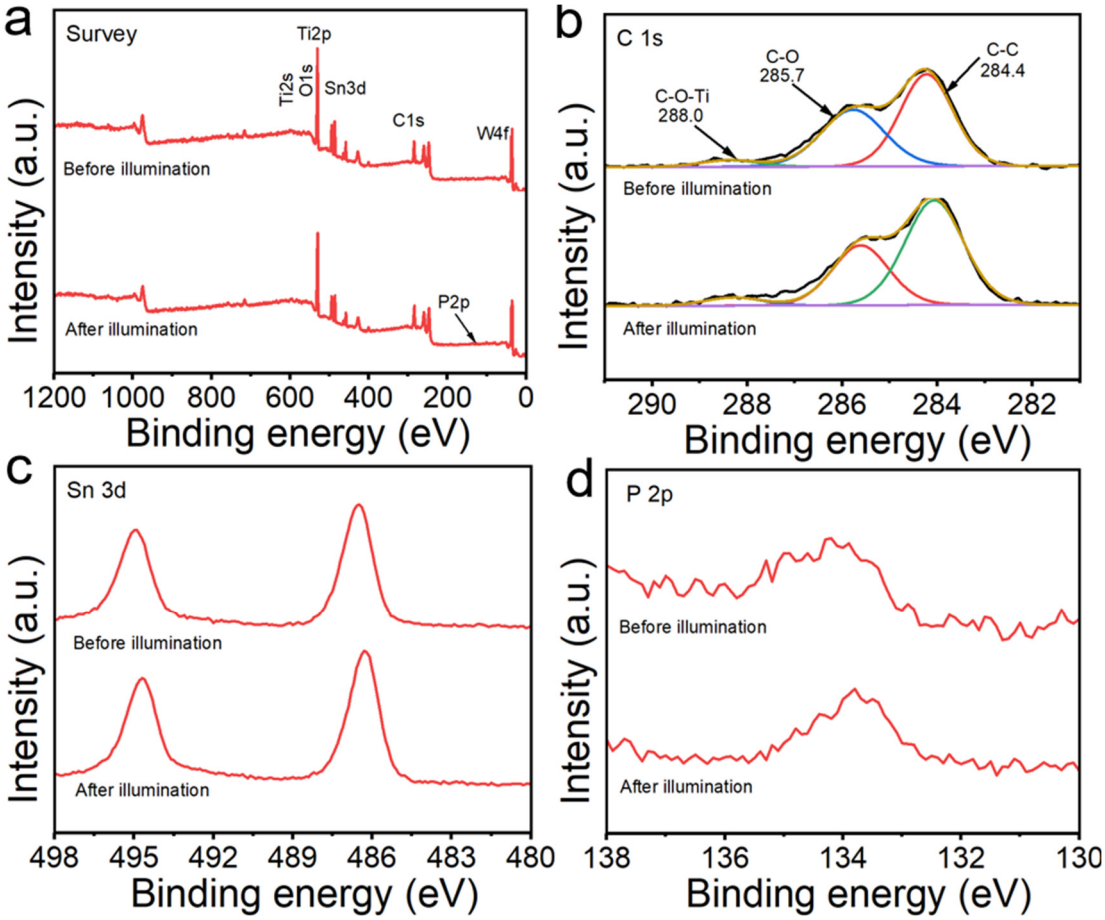

Figure S7. Survey XPS spectra (a) and high-resolution XPS spectra of C (b), P (c), N (d) of the Sn-TiO_2/PTA nanocomposite before and after 450nm illumination.

Table S1. Comparison of photochromic performance between Sn-TiO_2/PTA/PVP and existing systems.

System	Activation Wavelength (nm)	Coloration Time	Optical Contrast	Cycling Stability
Fe-WO_3/PVP[1]	365 (UV)	180 s	Blue	50
Fe-$W_{18}O_{49}$/PVP[2]	365 (UV)	120 s	Blue	50
WO_3-MoO_3/HEA/AM[3]	365 (UV)	300 s	Blue-black	10
SP-Naph[4]	365 (UV)	300 s	Blue	11
Sn-TiO_2/PTA/PVP	450 (Visible)	10 s	Black	80

HEA: 2-hydroxyethyl acrylate; **AM:** acrylamide; **SP-Naph:** naphthalene-embedded spiropyran

References

[1] Zhang, Y.; Wang, Q., Acceleration photochromic performance in tungsten oxide. *Opt. Mater.* **2024**, 157, 116365.

[2] Zhu, Y.; Li, B.; Li, C.; Tian, S., Transparent photochromic Fe-doped $W_{18}O_{49}$ films with ultrahigh solar energy modulation for smart windows. *J. Mater. Chem. C* **2025**, 13, 6115–6122.

[3] Oderinde, O.; Ejeromedoghene, O.; Fu, G., Synthesis and properties of low-cost, photochromic transparent hydrogel based on ethaline-assisted binary tungsten oxide-molybdenum oxide nanocomposite for optical memory applications. *Polym. Adv. Technol.* **2022**, 33, 687–699.

[4] Liu, T.; Li, J. L.; Xie, Z.; Huang, C.; Wang, J.; Zhang, C.; Sha, C.; Wang, L., Naphthalene-embedded spiropyran derivative-A type of conjugated expanded material with solid-state photochromic properties and tunable color switching range. *J. Mol. Struct.* **2024**, 1318, 139404.